Wireless transmitter and hearing system

The present invention departs from problems recognized at so-called "wireless microphones". We understand under a wireless microphone a system consisting of a transmitter unit with an input microphone arrangement and of a hearing device with a respective wireless receiver.

Audio signals perceived by the microphone arrangement of the transmitter unit, remote from the hearing device and e.g. carried at an individual's belt are wirelessly transmitted to the receiver of individual's hearing device, by means of a carrier frequency signal modulated with the audio signal as is perceived by the microphone.

In the hearing device, the audio-signal-modulated carrier frequency signal is demodulated and the audio signal recaptured is operationally connected to an electrical to mechanical converter of the hearing device, as to a loudspeaker unit.

Nevertheless, the problems and objects defined over such a system do also apply to other wireless transmitter units than those forming a part of wireless microphone systems, and the present invention therefore presents also solutions for such other wireless transmitters.

Wireless transmitters often have the option to transmit via their antennas on one hand with different, selectable carrier frequencies within one frequency band, but also within different frequency bands, also called channels. The frequency bands usable of such transmitters are usually

hardwired within the transmitter and may be changed by means of switches.

Nevertheless, a lot of countries legally restrict the frequency bands, which may be used for instance without special permission and additionally often also limit the power, i.e. the effectively radiated power (ERP) for transmitted signals, which do not require such special permission fee or tax. These restrictions are often different from country to country.

If the individual using the transmitter has free access to the carrier frequency band selector and thus to the frequency band exploited, he is likely to infringe the respective local regulations, even inadvertently. As a solution of this problem it would be possible to specifically tailor the transmitter for the respective country such that the user may not select another frequency band than the locally prescribed one, may only select carrier frequencies within that specific band, and also may not select higher output power than prescribed. This of course poses severe infrastructural, logistical as well as production problems to the manufacturer, which significantly raise the production price.

Furthermore, one and the same transmitter should be usable internationally as a respective individual customarily travels from country to country.

Instead of hardwiring the respective frequency band, the information about a selectable frequency band and, possibly, a derived power level may be stored in a memory, as e.g. in a non-volatile and re-programmable memory, as an

electrically erasable, programmable read-only memory (EEPROM). This has the advantage that this information and other possibly prescribed radiation parameters for the transmitter may be programmed in a late stage of production by physically establishing by EEPROM-programming the respective connections within the transmitter. However, in case of frequency band reallocation in an other country the transmitter must be collected and reprogrammed by a specialized center.

It is an object of the present invention to provide a safe and flexible way to set the frequency band and/or the effectively radiated power of a transmitter by untrained people and without using sophisticated procedures like EEPROM programming by specialized people.

This is achieved by the wireless transmitter according to the present invention, which comprises an antenna and a transmitter signal generator unit generating a signal to be transmitted at an output and having a control input. A control signal applied to this control input controls at least one of the frequency band wherein the at least one carrier frequency resides of the transmitted signal and of the power of the transmitted signal. The output of the generator unit is thereby connected to the antenna. There is further provided an audio signal to control signal decoder unit, which generates a control signal at an output in response to an encoded audio signal at its input. The output of the decoder unit is thereby operationally connected to the control input of the generator unit.

Thereby, we understand under an audio signal a signal which, generically spoken, may be converted by a microphone or, more general, a mechanical to electrical converter, and thereby considering ultra-sonic microphones too, goes up to ultra-sonic frequencies. Nevertheless, in a most preferred embodiment we understand under audio signals signals in the frequency range of 100 Hz up to 20 kHz. Thereby an encoded audio signal is not modulated upon a high-frequency carrier signal. An example of such encoding audio signal, which is also preferably used in the present invention, is the so-called DTMF, dual-tone multi-frequency encoding, which is widely known in the telephony technology.

Thus, such encoded audio signal may be output at any audio output and input to any audio input of respective devices.

According to the wireless transmitter of the present invention, selection of the respectively used frequency band and/or radiation power is controlled by the encoded audio signal. Due to the fact that respective encoding of the audio signal is e.g. only known to the manufacturer of the transmitter or to respectively licensed centers, it nevertheless becomes possible to easily reprogram the transmitter on the respective locally admitted frequency band and/or radiation power by the individual user. A respective audio-signal source is e.g. purchased from the manufacturer as e.g. a CD. The individual retrieves e.g. with entering a country code from such audio source the respectively encoded audio signal to the transmitter, which, via the audio signal to control signal decoder, reprograms his transmitter on the respective local

requirements with respect to frequency band and/or radiation power.

In a first preferred embodiment of the wireless transmitter according to the present invention, the input of the decoder unit is operationally connected to at least one audio signal input tab of the wireless transmitter. At this tab the encoded audio signal may be applied generically from an audio output of whatever audio signal source is selected.

Thereby, this input tab is connectable to at least one external audio signal source. Such an audio signal source may thereby preferably be at least one of a microphone, an internet connection device, an audio player as e.g. an MP3 player, a CD player, a tape player, a DVD player etc.

If the audio signal tab of the wireless transmitter is e.g. connected to a microphone, it becomes possible to enter the encoded audio signal on request via a telephone connection and thereby using acoustical coupler technique. If the tab is connected to the acoustical output of an internet connection device as to a computer or laptop's audio output, on respective request the user may receive e.g. from manufacturer's server the respectively encoded audio signal file and the transmitter is reprogrammed on the respective local requirements. By connecting the said tab of the wireless transmitter to an audio player audio output and by providing an audio signal carrier or storage medium for such player, e.g. with country-specific encoded audio signals, the individual user may easily reprogram his wireless transmitter by entering e.g. on the basis of a

country-selection code the respectively encoded audio signal to his individual transmitter.

In a further preferred embodiment of the wireless transmitter according to the present invention the generator unit comprises a modulator unit with a carrier frequency signal input and with an output. The output of the modulator unit is thereby operationally connected to the output of the generator unit and thus to the antenna of the transmitter. The modulator unit has further a modulation input which is operationally connected to the input of the audio signal to control signal decoder unit.

By this preferred embodiment and with an eye on the above explained wireless microphone arrangement, the audio signal input of the wireless transmitter is used on one hand for programming the respective frequency band and/or radiation power if a respectively encoded audio signal is applied thereto, and on the other hand an audio input acts on the modulation unit, so that the received audio input signal is modulated upon the carrier frequency signal and is transmitted to a respective receiver, especially to the receiver of an ear device of a wireless microphone system.

Thereby, the transmitted signal may be realized by one of the known modulation techniques, as especially by amplitude modulation, frequency modulation, phase modulation or a pulse modulation technique.

In a further preferred embodiment of the inventive transmitter, a microphone operationally connected to the audio input of the audio signal to control signal decoder is integrated in the transmitter itself. In a further

preferred embodiment the encoded audio signal is formed by a dual-tone multi-frequency-encoded audio signal. Thereby, although the inventive teaching may be applied up to ultrasonic audio-signals, in a preferred mode the addressed audio signals and thereby the addressed encoded audio signals are within the frequency range of 100 Hz to 20 kHz.

Although the one or all frequency bands to be selected may contain just one carrier frequency so that, in fact, instead of selecting a frequency band, just a carrier frequency may be selected, in a most preferred embodiment at least one frequency band to be selected contains more than one preselected carrier frequency. The carrier frequency to be applied is then selected, within the selected frequency band, by the individual. Most preferably the encoded audio signal thereby defines, at least within one of the frequency bands, more than one discrete carrier frequency.

The present invention further specifically addresses a wireless hearing system, which comprises on one hand an ear device with a wireless receiver unit operationally connected to an electrical to mechanical output converter. There is further provided the wireless transmitter as described and defined above, transmitting signals which are receivable and demodulatable at the ear device.

Further, the present invention provides for an audio signal carrier or storage medium, as e.g. a CD, a tape with a multitude of country-specific encoded audio signal files.

The present invention shall now be described in more details by way of examples and by means of figures.

The figures show:

Fig. 1 by means of a simplified signal flow/functional block diagram a first embodiment of a transmitter according to the present invention for inventively selecting the frequency band of wireless transmission;

Fig. 2 in a representation in analogy to that of fig. 1, a further embodiment of the transmitter according to the present invention for inventive selection of effectively radiated output power;

Fig. 3 in a representation in analogy to that of the figs. 1 and 2, a preferred embodiment of the transmitter according to the present invention for selecting frequency band of transmitted signals and effectively radiated output power of the transmitted signal;

Fig. 4 schematically, a wireless hearing system according to the present invention, basically consisting of a hearing device with wireless receiver and with a transmitter according to the present invention, and

Fig. 5 schematically, the file structure of an audio signal carrier according to the present invention for user-based programming of the transmitter according to the present invention.

According to fig. 1, which shows a first embodiment of the wireless transmitter according to the present invention, this wireless transmitter is shown in a dashed line frame

and denoted with ref. No. 1. The transmitter 1 comprises a transmitter signal generator unit 3. First generically addressing the present invention, the generator unit 3 comprises a carrier frequency signal generator unit 5 with a carrier frequency control input C_5. The carrier frequency control input C_5 is connected to a frequency band and carrier frequency selection unit 7, which has a control signal input C_7. By means of a control signal applied to control input C_7 first the frequency band, within which the transmitter 1 shall transmit, is selected. This is performed either by the control signal applied to C_7 controlling switches which enable a respective preprogrammed frequency band within unit 7.

Thus, in this case all the frequency bands, which possibly should be applicable, are preprogrammed in unit 7 and the control signal applied to C_7 merely performs a selection, which of the preprogrammed frequency bands shall be enabled.

In an other more preferred approach no frequency band is preprogrammed in unit 7. By means of the control signal applied to C_7 the unit 7 is programmed on that frequency band to be used. Thus by this preferred approach one frequency band information set is momentarily present in the transmitter 1.

Within the respective frequency bands customarily more than one discrete carrier frequency is selectable. If in a frequency band only one carrier frequency f_c shall be selectable, then the control signal at C_7 may clearly directly control selection of that carrier frequency. If

more than one carrier frequency f_c shall be selectable in at least one of the frequency bands as selectable or programmable by control signal applied to C_7, then the control signal to C_7 defines for these possible carrier frequencies. Preferably by means of a manually operable key 8 as schematically shown in Fig. 7 the specific carrier frequency f_c to be momentarily applied is selected.

Thus, in any case as described, a control signal applied to C_7 determines the frequency band to be activated in unit 7 and within that frequency band, by means of key 8 and a respective control signal to C_8 of unit 7, the individual selects the discrete carrier frequency preferably out of a number of carrier frequencies which are co-defined by the control signal applied to C_7.

The control input C_7 is thereby operationally connected to the output A_9 of an audio signal/control signal decoder unit 9. The decoder unit 9 has an audio input E_9, which is operationally connected to an input tab T_9 of the transmitter 1 for inputting audio signals.

The audio signal input tab T_9 of the transmitter 1 may thereby be connected to an audio signal source, thereby preferably to an external microphone or acoustical to electrical converter 11 and/or to a further source 13 of audio signals, as especially to an audio output of an internet connection device, of an audio player, as e.g. of an MP3 player, of a CD player, of a tape player, of a DVD player etc.

Nevertheless, in a preferred mode of the inventive transmitter there is provided at the transmitter 1 itself a

built-in or integrated microphone or acoustical to electrical converter 11 directly hardwired in operational connection with the audio input of the audio signal to control signal decoder unit 9.

By means of inputting an encoded audio signal to the audio input tab T_9 and/or to the built-in converter 11 of the transmitter 1 and by decoding this audio signal input there is generated at the output of the audio signal to control signal decoder unit 9 a band-selection control signal. By this signal preferably defining additionally for the specific carrier frequencies usable within that band and by carrier frequency selection by the control signal applied to control input C_8 of unit 7, the according discrete carrier frequency f_c is selected and the carrier frequency signal generator 5 is controlled to operate on that selected carrier frequency f_c. The carrier frequency signal is applied to a modulation unit 15, where the carrier frequency signal is modulated as a function of a modulation signal applied to modulation input mod of modulation unit 15. The modulated carrier frequency signal is then - via an output amplification stage 17 - operationally connected to a transmission antenna 19 of the transmitter 1.

Thereby and in a most preferred mode of the transmitter 1 according to the present invention the modulation input mod of the modulation unit 15 is operationally connected to the audio signal input E_9 of the audio signal to control signal decoder unit 9. Thus, an audio signal applied to audio input tab T_9 of the transmitter 1 is either modulated upon the carrier frequency signal as generated by generator 5

and then transmitted via antenna 19 or - if respectively encoded - is recognized by the audio signal to control signal decoder unit 9, decoded into a respective control or programming signal, which, as was explained, selects the respective frequency band and defines for the C_8-selectable carrier frequencies within that band to be applied.

The same is obviously valid if a microphone or acoustical to mechanical converter 11 is integrated in the transmitter 1 as according to a preferred mode of such transmitter.

In fig. 2 there is shown a further embodiment of the transmitter 1 according to the present invention. The same reference numbers as already used in fig. 1 are applied for the same inputs, outputs and units.

According to this embodiment there is used one fixed, preselected carrier frequency f_c. The carrier frequency signal generator 5a thereby generates again the carrier frequency signal to be modulated at modulator unit 15. The output amplification stage 17a has, in contrary to the embodiment of fig. 1, an output power selection control input C_{17} operationally connected to the output of a power level selection unit 21. The control signal input C_{21} of power level selection unit 21 is operationally connected to the control signal output A_9 of the audio signal to control signal decoder unit 9. Again the audio input E_9 of this decoder unit 9 is operationally connected to an audio signal input tab T_9 of the transmitter 1, being connectable to an audio output of an external microphone 11 or of an acoustical to electrical converter and/or to the audio output of another audio signal source as was described in

connection with fig. 1. Nevertheless, in the preferred embodiment again there is provided a microphone 11 or acoustical to electrical converter integrated in the transmitter 1 and hardwired in operational connection with audio input E_9 of audio signal to control signal decoder unit 9.

In analogy to the explanations with respect to fig. 1 in this embodiment by respective encoded audio signals applied either to integrated microphones and/or to audio input tab T_9 and by respective decoding via decoder unit 9 the output power level of the signals transmitted via antenna 19 is selected and realized by e.g. appropriate adjustment of output amplifier stage 17a.

Again in a preferred embodiment as shown in fig. 2 too the audio input to the decoder unit 9 is operationally connected to the modulation input mod of modulation unit 15.

In fig. 3 there is shown in an analogous representation to those of figs. 1 and 2 a preferred embodiment of the transmitter 1 according to the present invention, wherein the embodiment of fig. 1, namely encoded audio signal controlled band selection, and the embodiment of fig. 2, namely encoded audio signal controlled output power of transmitted signal, are both combined. The same reference numbers as of figs. 1 and 2 are applied, so that no further explanations are necessary for the skilled artisan and with respect to fig. 3.

Modulation of the carrier frequency signal as generated by the generator units 5 and 5a respectively is performed at

the modulation unit 15 and as a function of a signal applied to its modulation input mod in one of well-known modulation techniques, as especially by amplitude modulation, frequency modulation, phase-, respectively angle-modulation or by a pulse modulation technique. As was mentioned above encoding of the audio signal applied to audio input tab T_9 and/or to a built-in microphone and thereby led to the input of the audio signal to control signal decoder unit 9 is preferably performed by dual-tone multi-frequency encoding.

In fig. 4 there is schematically shown a hearing system according to the present invention. Such system consists of at least one ear device 30 with an electrical/mechanical output converter 32 acting on an individual's ear. The ear device 30 comprises, as schematically shown, a receiver unit with a reception antenna 34 and a demodulator DEM unit 36. The system further comprises a wireless transmitter 1 according to the other aspect of the present invention, and as was described with the help of the figs. 1 to 3, not further described here. An audio signal applied to the audio input tab T_9 of the transmitter or to its built-in microphone according to the present invention primarily modulates the carrier frequency signal. The audio signal modulated carrier frequency signal is transmitted via transmitter antenna 19 to receiver antenna 34 of the ear device 30.

Thereby, audio signals applied to the integrated microphone and/or to the audio input tab T_9 are wirelessly transmitted to the ear device 30 and may be listened at by the user.

The respective transmission frequency band and/or the transmitted signal power is selected by applying as was described with the help of figs. 1 to 3 an encoded audio signal to the audio input tab T_9 and/or built-in hardwire microphone. Selection of a discrete carrier frequency is preferably performed manually, e.g. at key 8.

As was mentioned above, the user of a transmitter according to figs. 1 to 3 and/or of a hearing system as according to fig. 4 may easily reprogram transmitter 1 with respect to frequency band - therein applicable carrier frequencies - and/or transmission power. This may e.g. be done by providing an audio signal carrier 20 to the individual as e.g. a CD. On such a carrier different encoded audio signal files are stored, as schematically shown in fig. 5, for a CD e.g. on different tracks.